

Principles of Technology I

3220

Course Description

Principles of Technology I is a laboratory science course that deals with the relationship between matter and energy and how they interact. This course will have a strong emphasis in the application of physics in technology. Completion of Principles of Technology I satisfies a lab science credit.

Principles of Technology I students will study:

- Force
- Work and Power
- Rate
- Resistance
- Energy
- Force Transformers

Embedded Inquiry

Conceptual Strand

Understandings about scientific inquiry and the ability to conduct inquiry are essential for living in the 21st century.

Guiding Question

What tools, skills, and knowledge are needed to conduct scientific inquiry?

Course Level Expectations

CLE 3220.Inq.1 Recognize that science and technology are progressive endeavors that reevaluate and extend what is already accepted.

CLE 3220.Inq.2 Design and conduct scientific investigations to explore new phenomena, verify previous results, test how well a theory predicts, and compare opposing theories.

CLE 3220.Inq.3 Use appropriate tools and technology to collect precise and accurate data.

CLE 3220.Inq.4 Apply qualitative and quantitative measures to analyze data and draw conclusions that are free of bias.

CLE 3220.Inq.5 Compare experimental evidence and conclusions with those drawn by others about the same testable question.

CLE 3220.Inq.6 Communicate and defend scientific findings.

Checks for Understanding (Formative/Summative Assessment)

- ✓**3220.Inq.1** Conduct scientific investigations that include testable questions, verifiable hypotheses, and appropriate variables to explore new phenomena or verify the experimental results of others.
- ✓**3220.Inq.2** Select appropriate independent, dependent, or controlled variables for an experiment.
- ✓**3220.Inq.3** Analyze the components of a properly designed scientific investigation.
- ✓**3220.Inq.4** Perform an experiment to test a prediction.
- ✓**3220.Inq.5** Select appropriate tools and technology to collect precise and accurate quantitative and qualitative data.
- ✓**3220.Inq.6** Determine if data supports or contradicts a hypothesis or conclusion.
- ✓**3220.Inq.7** Recognize, analyze, and evaluate alternative explanations for the same set of observations.
- ✓**3220.Inq.8** Evaluate the accuracy and precision of data.
- ✓**3220.Inq.9** State a conclusion in terms of the relationship between two or more variables.
- ✓**3220.Inq.10** Defend a conclusion based on scientific evidence.
- ✓**3220.Inq.11** Analyze experimental results and identify possible sources of bias or experimental error.
- ✓**3220.Inq.12** Compare the results of an experiment with what is already known about the topic under investigation.
- ✓**3220.Inq.13** Suggest alternative explanations for the same set of observations.
- ✓**3220.Inq.14** Formulate and revise models using logic and evidence.
- ✓**3220.Inq.15** Compare conclusions that offer different, but acceptable explanations for the same set of experimental data.

Embedded Mathematics

Conceptual Strand

Investigating physics principles is accomplished by applying mathematical rules.

Guiding Question

What skills and understandings of mathematics are needed to investigate physics?

Course Level Expectations

- CLE.3220 Math.1** Graph relationships and functions between manipulated (independent) variables and responding (dependent) variables.
- CLE.3220 Math.2** Solve for variables in an algebraic formula.
- CLE.3220 Math.3** Apply statistical techniques to manipulate data.
- CLE.3220 Math.4** Investigate trigonometric connections to technology.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3220.Math.1** Plot points on the Cartesian coordinate graphing system.
- ✓ **3220.Math.2** Graph basic relations and functions using a graphing calculator or a computer program.
- ✓ **3220.Math.3** Determine the slope of a linear function.
- ✓ **3220.Math.4** Determine the frequency, range, mode, median, and mean from a list of data.
- ✓ **3220.Math.5** Utilize a graphing calculator or a computer program to enter data and find basic statistics: frequency, range, means, mode, median, and standard deviation.
- ✓ **3220.Math.6** Solve for all variables based on a formula.
- ✓ **3220.Math.7** Utilize trigonometric functions (sine, cosine, and tangent) to solve simple vector problems.
- ✓ **3220.Math.8** Apply the laws of sine and cosine to solve vector problems.
- ✓ **3220.Math.9** Solve mechanics problems using the quadratic formula.
- ✓ **3220.Math.10** Solve mechanics problems using radians, degrees and revolutions.

Embedded Technology and Engineering

Conceptual Strand

Society benefits when engineers apply scientific discoveries to design materials and processes that develop into enabling technologies.

Guiding Question

How do science concepts, engineering skills, and applications of technology improve the quality of life?

Course Level Expectations

- CLE 3220.T/E.1** Explore the impact of technology on social, political, and economic systems.
- CLE 3220.T/E.2** Differentiate among elements of the engineering design cycle: design constraints, model building, testing, evaluating, modifying, and retesting.
- CLE 3220.T/E.3** Explain the relationship between the properties of a material and the use of the material in the application of a technology.
- CLE 3220.T/E.4** Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.
- CLE 3220.T/E.5** Comply with all local, state, and federal safety regulations.

Checks for Understanding (Formative/Summative Assessment)

- ✓ **3220.T/E.1** Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.
- ✓ **3220.T/E.2** Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.

- ✓**3220.T/E.3** Evaluate a protocol to determine the degree to which an engineering design process was successfully applied.
- ✓**3220.T/E.4** Explore how the unintended consequences of new technologies can impact human and non-human communities.
- ✓**3220.T/E.5** Evaluate the overall benefit to cost ratio of a new technology.
- ✓**3220.T/E.6** Present research on current bioengineering technologies that advance health and contribute to improvements in our daily lives.
- ✓**3220.T/E.7** Design a series of multi-view drawings that can be used by other students to construct an adaptive design and test its effectiveness.
- ✓**3220.T/E.8** Apply industry standard measurements and identifiers.

Standard I – Mechanical

Conceptual Strand I

Laws, properties and applications of mechanics are the foundations of principles of technology.

Guiding Question I

How do the laws, properties, and application of mechanics govern the understanding of technology?

Course Level Expectations

- CLE 3220.1.1 Investigate fundamental mechanical quantities of force.
- CLE 3220.1.2 Investigate fundamental mechanical quantities of work and power.
- CLE 3220.1.3 Investigate fundamental mechanical quantities of rate.
- CLE 3220.1.4 Investigate fundamental mechanical quantities of resistance.
- CLE 3220.1.5 Investigate fundamental mechanical quantities of energy.
- CLE 3220.1.6 Investigate fundamental mechanical quantities of force transformers.

Checks for Understanding (Formative/Summative Assessment)

- 3220.1.1.a Distinguish between units of force in the SI and the English systems.
- b Distinguish between scalar and vector quantities of force.
- c Investigate the forces involved in determining torque.
- d Measure torque forces using appropriate tools.
- e Analyze force as it applies to Newton's three laws of motion.

- f Explain the relationship of input work and output work in linear and rotational force transformers.
- g Use equations of work in equals work out to find an unknown force or displacement when using a pulley system or a lever as the force transformer.
- h Explain the difference between ideal mechanical advantage (IMA) and actual mechanical advantage (AMA).
- i Use force transformer equations to find IMA and AMA.
- j Identify different kinds of force transformers for linear mechanical systems and rotational systems.
- k Calculate efficiency of force transformers using IMA and AMA equations.
- l Find the mechanical advantage of rotational force transformers using appropriate units.
- 3220.1.2.a Distinguish between units of work and power in the SI and the English systems.
- b Explain the relationship between work done on an object, force applied, and the distance at which the object moves.
- c Measure work done in linear and rotational systems to include radians and degrees.
- d Analyze the efficiency of mechanical systems as related to input work and output work.
- 3220.1.3.a Distinguish between units of rate in the SI and the English systems.
- b Calculate and measure speed and velocity in linear and rotational systems.
- c Calculate and measure acceleration in linear and rotational systems.
- d Describe how a voltage transformer is used to step up or step down voltage.
- 3220.1.4.a Explain the relationship between frictional force (f), the coefficient of friction (μ), and the force pressing two surfaces together (N).
- b Distinguish between static and kinetic friction.
- c Distinguish between surface friction and fluid drag.
- 3220.1.5.a Distinguish between gravitational potential energy and elastic potential energy.
- b Distinguish between potential and kinetic energy.
- c Using Hooke's law, calculate the potential energy of a spring.

- d Distinguish between linear kinetic energy and rotational kinetic energy.
- e Calculate gravitational potential energy, kinetic energy (linear and rotational), and elastic potential energy.
- f Use the law of conservation of energy to describe how one form of energy changes to another form with no loss of energy.
- g Determine the moment of inertia of a spinning object based on the object's mass, shape, and axis of rotation.

Standard II – Fluids

Conceptual Strand II

The physical laws and properties of fluids are an integrated part of how technology works.

Guiding Question II

How do the laws and properties of fluids govern the basic understanding of technology?

Course Level Expectations

- CLE 3220.2.1 Investigate fundamental fluid quantities of force.
- CLE 3220.2.2 Investigate fundamental fluid quantities of work and power.
- CLE 3220.2.3 Investigate fundamental fluid quantities of rate.
- CLE 3220.2.4 Investigate fundamental fluid quantities of resistance.
- CLE 3220.2.5 Investigate fundamental fluid quantities of energy.
- CLE 3220.2.6 Investigate fundamental fluid quantities of force transformers.

Checks for Understanding (Formative/Summative Assessment)

- 3220.2.1.a Distinguish the difference between hydraulic and pneumatic fluid systems.
- b Distinguish between density and specific gravity, using the formula $D=m/v$.
- c Explore buoyant force using Archimedes principle.
- d Use Pascal's law $\text{pressure}=\text{force}/\text{area}$.
- e Measure fluid pressure differences using appropriate meters (manometer, pressure gauge).

- f Differentiate between gauge pressure and absolute pressure.
- 3220.2.2.a Define work in a fluid system, using metric or English units.
- b Describe open and closed systems.
- c Calculate work done in open and closed systems.
- d Define power in a fluid system, using metric or English units.
- e Calculate efficiency by dividing power out by power in.
- 3220.2.3.a Calculate fluid flow rate by using either volume or mass of a fluid divided by time.
- b Identify various situations in daily living where volume and mass flow are calculated.
- 3220.2.4.a Describe resistance as an opposition to fluid motion.
- b Explain the difference between laminar and turbulent flow.
- c Explain the difference between mechanical and fluid drag.
- e Describe how to reduce the resistance of fluid flow.
- f Describe how length, diameter, and viscosity affect fluid flow.
- 3220.2.5.a Relate energy in fluid systems to energy in mechanical systems.
- b Explain and demonstrate Bernoulli's principle.
- 3220.2.6.a Explain how hydraulic jack works as fluid force transformer.
- b Explain how force is amplified through mechanical advantage in a fluid system.
- c Identify various fluid transformers.

Standard III – Electrical

Conceptual Strand III

Laws, properties, and applications of electricity are part of the foundations of today's technology.

Guiding Question III

How do the laws, properties, and applications of electricity govern the use and development of technology.

Course Level Expectations

- CLE 3220.3.1 Investigate fundamental electrical quantities of force.
- CLE 3220.3.2 Investigate fundamental electrical quantities of work and power.
- CLE 3220.3.3 Investigate fundamental electrical quantities of rate.
- CLE 3220.3.4 Investigate fundamental electrical quantities of resistance.
- CLE 3220.3.5 Investigate fundamental electrical quantities of energy.
- CLE 3220.3.6 Investigate fundamental electrical quantities of force transformers.

Checks for Understanding (Formative/Summative Assessment)

- 3220.3.1.a Explain the two types of electricity (direct and alternating current).
- b Identify the components of the circuit.
- c Investigate circuit schematics.
- d Sketch an electrical schematic for series and parallel circuits.
- e Construct a series and a parallel circuit and measure voltages.
- f Use a multimeter (digital and analog) to measure voltage.
- g Explain how electrical forces create voltage.
- 3220.3.2.a Calculate work in electrical systems, given voltage and charge, using appropriate units.
- b Measure current in the circuit using a multimeter.
- c Set up a multimeter to measure current.
- d Construct a circuit, with proper meter placement, to measure current and voltage.
- e Define joule as a unit of measurement.
- f Calculate efficiency, using input electrical work and output mechanical work.
- g Define the mechanical and electrical work involved in the operation of a solenoid.
- h Define power in an electrical system as electrical work divided by time.
- i Measure power in an electrical system using proper units.
- 3220.3.3.a Describe charge flow rate (I) as a quantity of charge moved (Q) per unit of time (t) or $I=Q/t$.
- b Distinguish between frequency and period.
- c Calculate frequency and period using measurements read from the oscilloscope.

- 3220.3.4.a Describe resistance in electrical systems.
- b Explain the differences among conductors, insulators, and semi-conductors, based on the material's resistivities.
- c Compare the accuracy of resistance by color code to actual readings made with a digital multimeter.
- d Use Ohm's law to calculate the resistance in a circuit.
- e Show how resistance in a wire depends on (1) length of the wire, (2) cross-sectional area of the wire, and (3) material of which the wire is made.
- f Measure resistance in electrical systems and calculate in appropriate units.
- g Calculate resistance in both series and parallel circuits, using appropriate formulas.

- 3220.3.5.a Describe the nature and storage of electrical potential energy in a capacitor and a conductor.
- b Describe how a capacitor and a inductor work.
- c Measure the energy needed to charge a capacitor and the energy released upon discharge, using a multimeter.
- d Discuss the relationship between work and electrical energy.

- 3220.3.6.a Demonstrate how a voltage transformer is used to step up or step down voltage.
- b Explain the relationship between voltage in, voltage out, and number of wire windings in a voltage transformer.
- c Find the mechanical advantage of a voltage transformer.
- d Calculate the operating efficiency of a voltage transformer.

Standard IV – Thermal

Conceptual Strand IV

Understanding the laws of thermal energy is essential to understanding modern technology.

Guiding Question IV

How are the laws of thermal energy essential to understanding modern technology?

Course Level Expectations

- CLE 3220.4.1 Investigate fundamental thermal quantities of force.
 - CLE 3220.4.2 Investigate fundamental thermal quantities of power.
 - CLE 3220.4.3 Investigate fundamental thermal quantities of rate.
 - CLE 3220.4.4 Investigate fundamental thermal quantities of resistance.
 - CLE 3220.4.5 Investigate fundamental thermal quantities of energy.
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- CLE 3220.4.1a Identify the direction of movement of heat energy in a thermal system when temperature information is known.
 - b Name and describe the force-like quantity in a thermal system.
 - c Differentiate between the Fahrenheit and Celsius scales.
 - d Measure temperature with devices (thermometers, thermocouples) and convert between the Fahrenheit and Celsius scales.
 - CLE 3220.4.2a Define power in a thermal system as energy divided by time.
 - CLE 3220.4.3a Calculate heat-flow rate Q_H as heat energy (H) moved per unit time (t), using appropriate units.
 - b Define specific heat capacity.
 - c Explain the difference between sensible heat and latent heat as it relates to change of state.
 - d Measure specific heat of different metals.
 - CLE 3220.4.4a Describe resistance in a thermal system
 - b Define thermal conductivity (k) as a measure of certain materials' ability to conduct heat.
 - c Explain the relationship between resistance, temperature difference, and heat flow.
 - CLE 3220.4.5a Describe the relationship between thermal energy and work.
 - b Describe and calculate the mechanical equivalent of heat.
 - c Discuss the three ways that heat energy is transferred.
 - d Describe the role heat energy in the law of conservation.